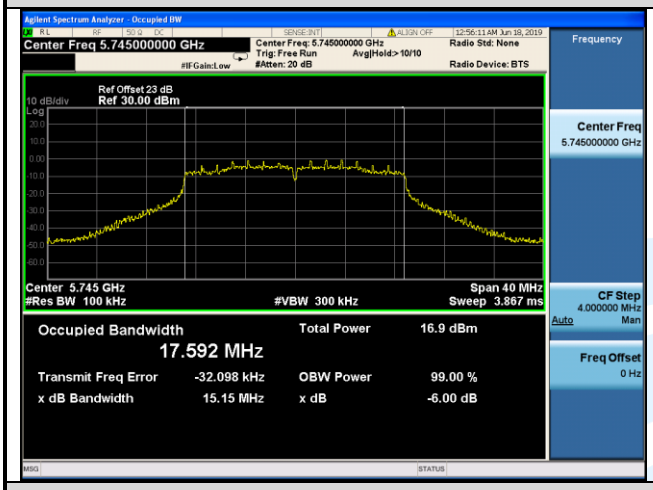
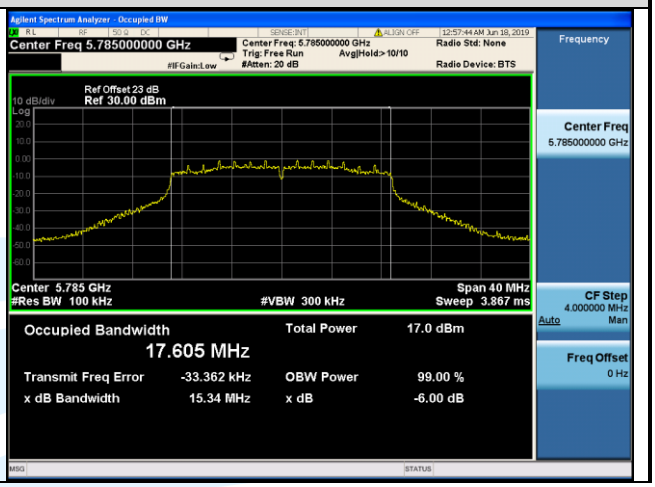
IEEE 802.11ac-VHT20

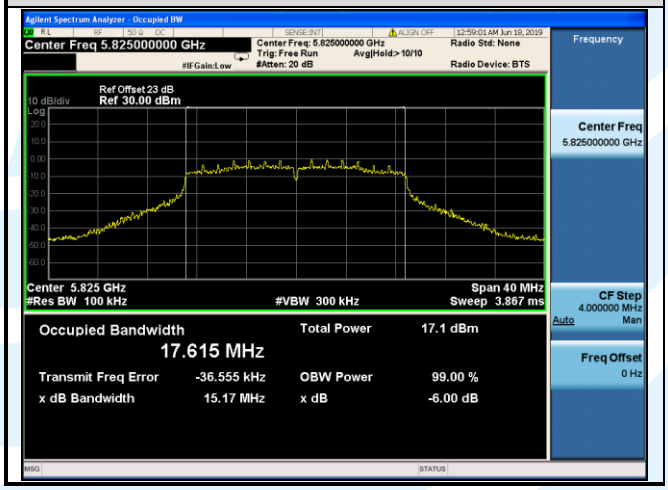
Channel 149

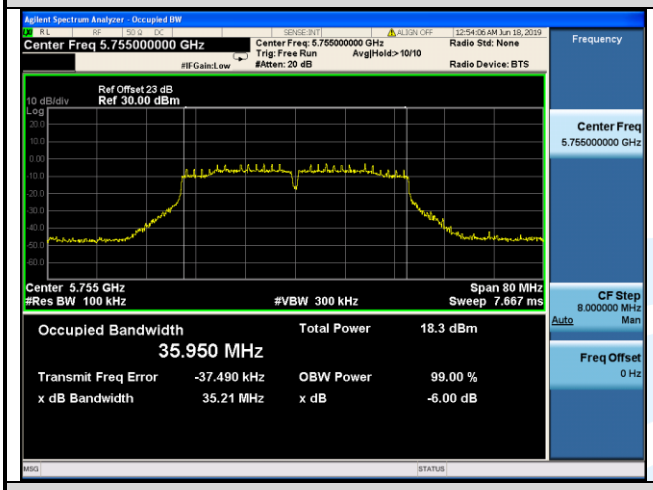
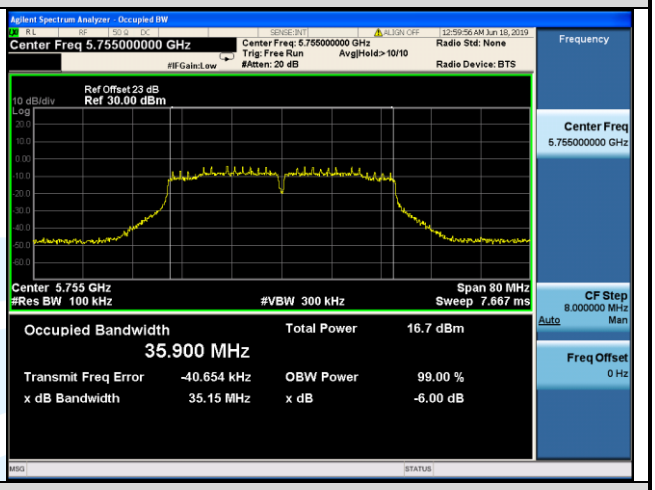
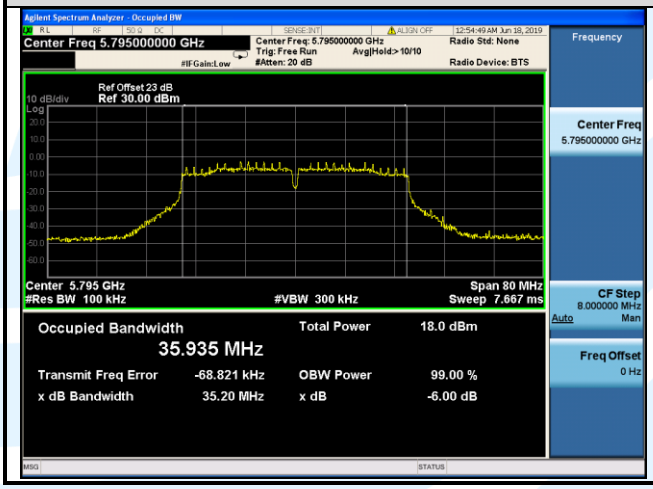
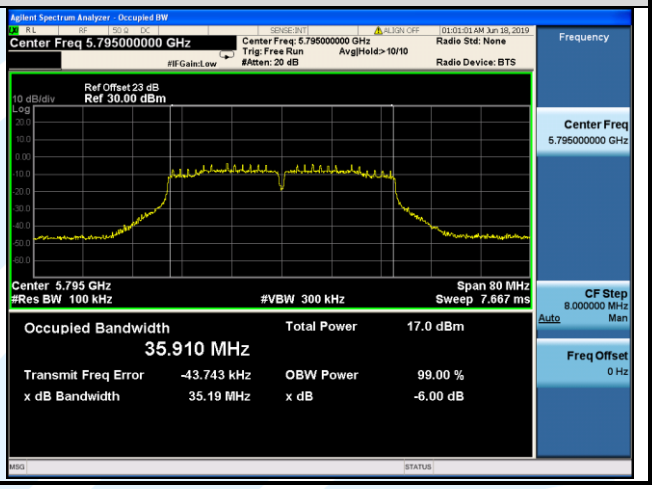


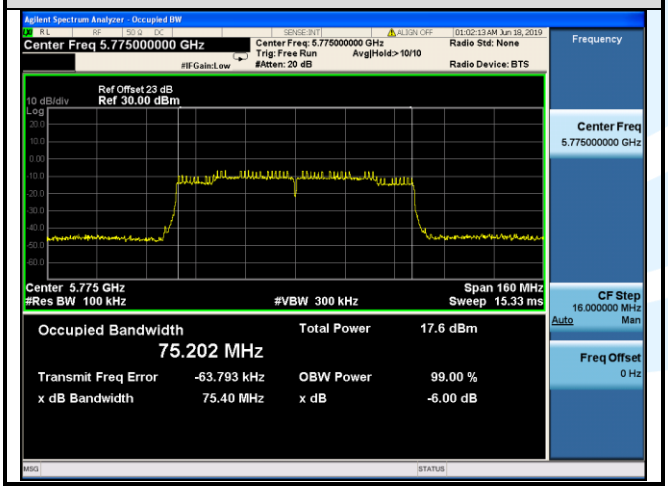
Channel 157



Channel 165



IEEE 802.11n-HT40	IEEE 802.11ac-VHT40
Channel 151	
	
Channel 159	
	

IEEE 802.11ac-VHT80
Channel 155


5.5 MAXIMUM CONDUCTED OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)

Test Method: KDB 789033 D02 v02r01 Section E.3.a(Method PM)

Limits:

1. For the band 5.15-5.25 GHz.
   (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

   (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

   (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

   (iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2. For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3. For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Test Procedure:

1. Connected the EUT's antenna port to measure device by 10dB attenuator.
2. Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of Tx on burst.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Antenna gain and the maximum output power limit.

Frequency Band	Antenna Gain (dBi))	Peak Power Limits (dBm)
U-NII-1	2.56	24.00
U-NII-2C	2.66	24.00
U-NII-3	3.12	30.00

For U-NII-1 Band:

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Limit (dBm)	Pass / Fail
		Meas Power	Corr'd Power		
IEEE 802.11a	36 (5180)	11.35	11.35	24	Pass
	44 (5220)	11.11	11.11	24	Pass
	48 (5240)	10.67	10.67	24	Pass
IEEE 802.11n-HT20	36 (5180)	10.55	10.55	24	Pass
	44 (5220)	10.34	10.34	24	Pass
	48 (5240)	10.12	10.12	24	Pass
IEEE 802.11n-HT40	38 (5190)	10.55	10.55	24	Pass
	46 (5230)	10.36	10.36	24	Pass
IEEE 802.11ac-VHT20	36 (5180)	10.33	10.33	24	Pass
	44 (5220)	10.11	10.11	24	Pass
	48 (5240)	9.88	9.88	24	Pass
IEEE 802.11ac-VHT40	38 (5190)	10.48	10.48	24	Pass
	46 (5230)	10.05	10.05	24	Pass
IEEE 802.11ac-VHT80	42 (5210)	11.13	11.13	24	Pass

Remark:

1. Corr'd Power = Meas Power + Duty Cycle Factor

For U-NII-2C Band:

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Limit (dBm)	Pass / Fail
		Meas Power	Corr'd Power		
IEEE 802.11a	100 (5500)	11.79	11.79	24	Pass
	116 (5580)	12.35	12.35	24	Pass
	140 (5700)	12.71	12.71	24	Pass
IEEE 802.11n-HT20	100 (5500)	12.55	12.55	24	Pass
	116 (5580)	12.72	12.72	24	Pass
	140 (5700)	12.65	12.65	24	Pass
IEEE 802.11n-HT40	102 (5510)	10.39	10.39	24	Pass
	110 (5550)	10.43	10.43	24	Pass
	134 (5670)	10.51	10.51	24	Pass
IEEE 802.11ac-VHT20	100 (5500)	11.58	11.58	24	Pass
	116 (5580)	11.47	11.47	24	Pass
	140 (5700)	11.91	11.91	24	Pass
IEEE 802.11ac-VHT40	102 (5510)	9.88	9.88	24	Pass
	110 (5550)	9.95	9.95	24	Pass
	134 (5670)	9.94	9.94	24	Pass
IEEE 802.11ac-VHT80	106 (5530)	12.01	12.01	24	Pass

Remark:

1. Corr'd Power = Meas Power + Duty Cycle Factor

Note:

For IEEE 802.11 a/n/ac, the minimum -26dB emission bandwidth is 20.12 MHz
11 dBm + $10\log_{10}(20.12)$ = 24.04 dBm > 24 dBm (250mW)
So the 24 dB limit applicable

For U-NII-3 Band:

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Limit (dBm)	Pass / Fail
		Meas Power	Corr'd Power		
IEEE 802.11a	149 (5745)	13.88	13.88	30	Pass
	157 (5785)	13.66	13.66	30	Pass
	165 (5825)	13.61	13.61	30	Pass
IEEE 802.11n-HT20	149 (5745)	12.64	12.64	30	Pass
	157 (5785)	12.71	12.71	30	Pass
	165 (5825)	12.67	12.67	30	Pass
IEEE 802.11n-HT40	151 (5755)	12.47	12.47	30	Pass
	159 (5795)	12.55	12.55	30	Pass
IEEE 802.11ac-VHT20	149 (5745)	11.61	11.61	30	Pass
	157 (5785)	11.72	11.72	30	Pass
	165 (5825)	12.06	12.06	30	Pass
IEEE 802.11ac-VHT40	151 (5755)	11.78	11.78	30	Pass
	159 (5795)	11.85	11.85	30	Pass
IEEE 802.11ac-VHT80	155 (5775)	12.36	12.36	30	Pass

Remark:

1. Corr'd Power = Meas Power + Duty Cycle Factor

5.6 PEAK POWER SPECTRAL DENSITY

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)

Test Method: KDB 789033 D02 v02r01 Section F

Limits:

1. For the band 5.15-5.25 GHz.
   (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

   (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

   (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

   (iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2. For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
3. For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Test Procedure:

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer.

Spectrum analyzer according to the following Settings:

1. For U-NII-1, U-NII-2A, U-NII-2C band:

Using method SA-2

a) Set span to encompass the entire emission bandwidth (EBW) of the signal.
b) Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
c) Sweep time = auto, trigger set to “free run”.
d) Trace average at least 100 traces in power averaging mode.
e) Record the max value and add 10 log (1/duty cycle)

2. For U-NII-3 band:

a) Set span to encompass the entire emission bandwidth (EBW) of the signal.
b) Set RBW = 500 kHz, Set VBW ≥ 3 RBW, Detector = RMS
c) Use the peak marker function to determine the maximum power level in any 500 kHz band segment within the fundamental EBW.
d) Sweep time = auto, trigger set to “free run”.
e) Trace average at least 100 traces in power averaging mode.
f) Record the max value and add 10 log (1/duty cycle)

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Antenna gain and the maximum output power limit.

Frequency Band	Antenna Gain (dBi))	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	2.56	11.00
U-NII-2C	2.66	11.00
U-NII-3	3.12	30.00

For U-NII-1 Band:

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz)		Limit (dBm/MHz)	Pass / Fail
		Meas PSD	Corr'd PSD		
IEEE 802.11a	36 (5180)	0.073	0.073	11	Pass
	44 (5220)	-1.711	-1.711	11	Pass
	48 (5240)	-2.283	-2.283	11	Pass
IEEE 802.11n-HT20	36 (5180)	-2.666	-2.666	11	Pass
	44 (5220)	-2.489	-2.489	11	Pass
	48 (5240)	2.869	2.869	11	Pass
IEEE 802.11n-HT40	38 (5190)	-5.823	-5.823	11	Pass
	46 (5230)	-6.429	-6.429	11	Pass
IEEE 802.11ac-VHT20	36 (5180)	-2.466	-2.466	11	Pass
	44 (5220)	-2.703	-2.703	11	Pass
	48 (5240)	-4.273	-4.273	11	Pass
IEEE 802.11ac-VHT40	38 (5190)	-5.444	-5.444	11	Pass
	46 (5230)	-5.838	-5.838	11	Pass
IEEE 802.11ac-VHT80	42 (5210)	-10.612	-10.612	11	Pass

Remark:

1. Corr'd PSD = Meas PSD + Duty Cycle Factor

For U-NII-2C Band:

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz)		Limit (dBm/MHz)	Pass / Fail
		Meas PSD	Corr'd PSD		
IEEE 802.11a	100 (5500)	-0.926	-0.926	11	Pass
	116 (5580)	0.839	0.839	11	Pass
	140 (5700)	1.469	1.469	11	Pass
IEEE 802.11n-HT20	100 (5500)	-0.230	-0.230	11	Pass
	116 (5580)	1.779	1.779	11	Pass
	140 (5700)	4.423	4.423	11	Pass
IEEE 802.11n-HT40	102 (5510)	-4.935	-4.935	11	Pass
	110 (5550)	-4.057	-4.057	11	Pass
	134 (5670)	-4.303	-4.303	11	Pass
IEEE 802.11ac-VHT20	100 (5500)	-0.816	-0.816	11	Pass
	116 (5580)	1.396	1.396	11	Pass
	140 (5700)	1.263	1.263	11	Pass
IEEE 802.11ac-VHT40	102 (5510)	-5.125	-5.125	11	Pass
	110 (5550)	-4.188	-4.188	11	Pass
	134 (5670)	-3.373	-3.373	11	Pass
IEEE 802.11ac-VHT80	106 (5530)	-6.653	-6.653	11	Pass

Remark:

1. Corr'd PSD = Meas PSD + Duty Cycle Factor

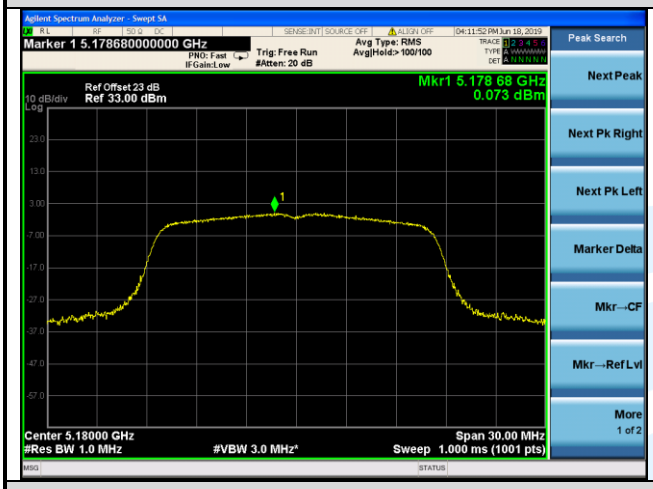
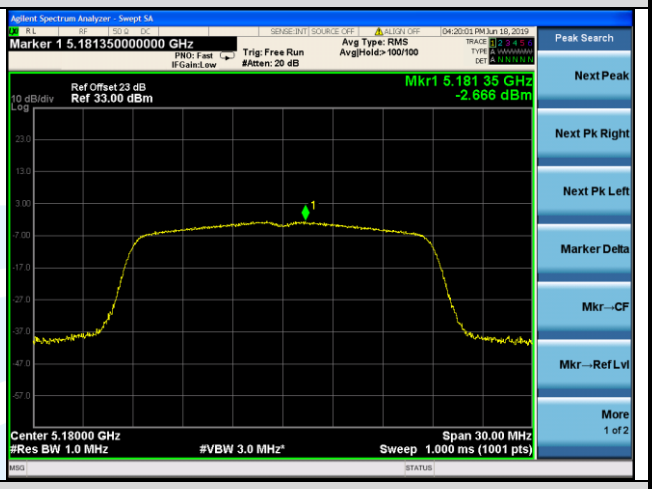
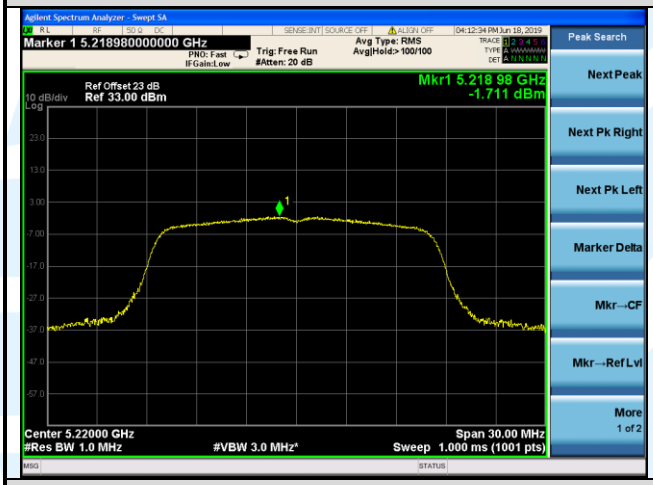
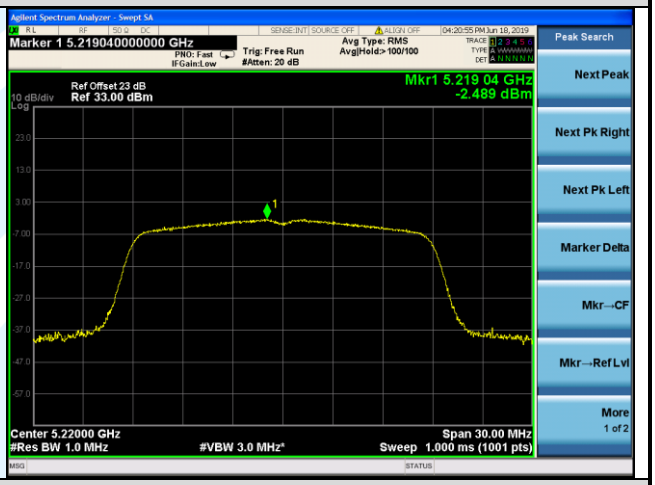
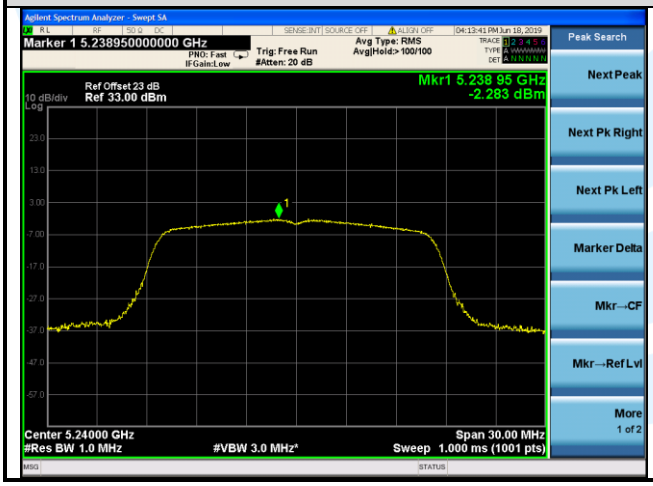
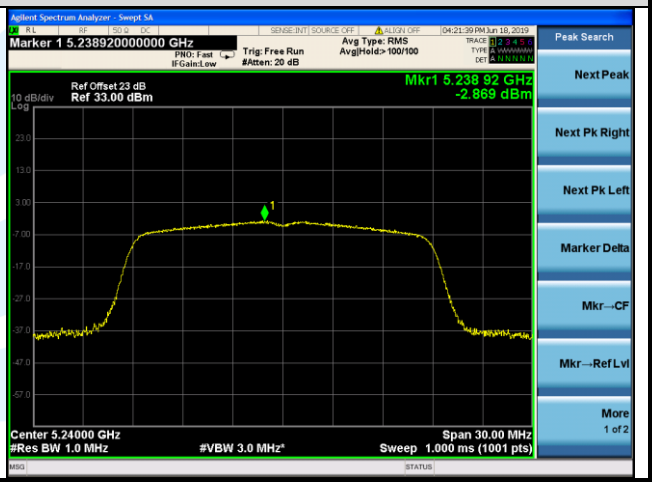
For U-NII-3 Band:

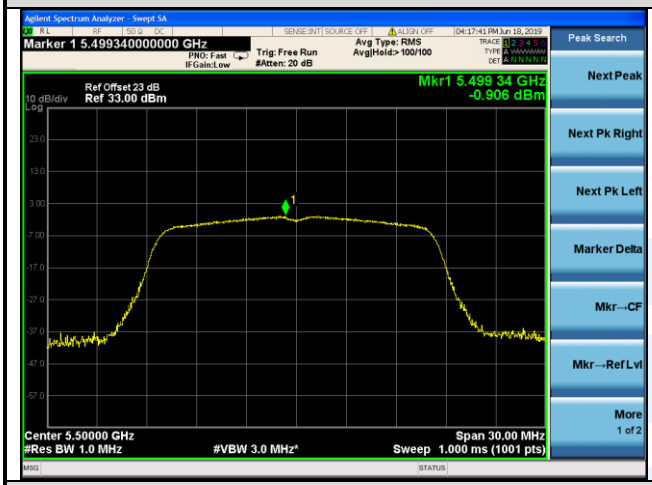
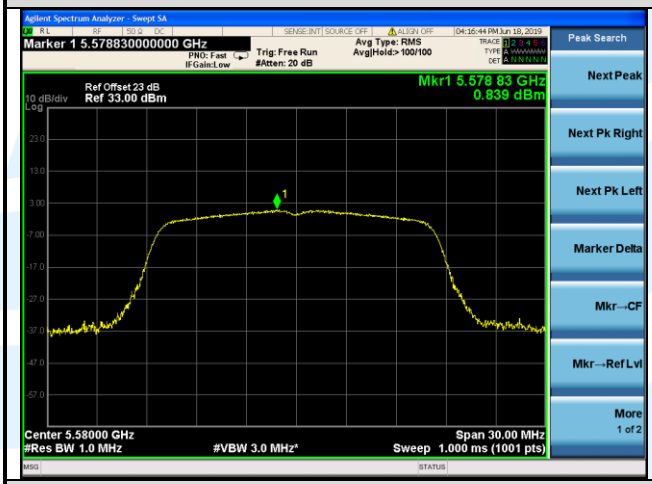
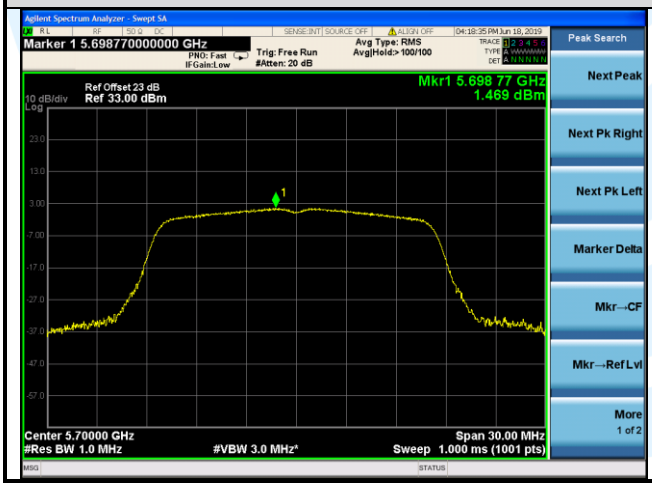
Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/500KHz)		Limit (dBm/500KHz)	Pass / Fail
		Meas PSD	Corr'd PSD		
IEEE 802.11a	149 (5745)	2.870	2.870	30	Pass
	157 (5785)	1.806	1.806	30	Pass
	165 (5825)	0.849	0.849	30	Pass
IEEE 802.11n-HT20	149 (5745)	2.236	2.236	30	Pass
	157 (5785)	0.976	0.976	30	Pass
	165 (5825)	-0.132	-0.132	30	Pass
IEEE 802.11n-HT40	151 (5755)	-2.716	-2.716	30	Pass
	159 (5795)	-4.228	-4.228	30	Pass
IEEE 802.11ac-VHT20	149 (5745)	1.535	1.535	30	Pass
	157 (5785)	-0.704	-0.704	30	Pass
	165 (5825)	-0.959	-0.959	30	Pass
IEEE 802.11ac-VHT40	151 (5755)	-2.962	-2.962	30	Pass
	159 (5795)	-4.046	-4.046	30	Pass
IEEE 802.11ac-VHT80	122 (5610)	-5.571	-5.571	30	Pass
	155 (5775)	--4.877	--4.877	30	Pass

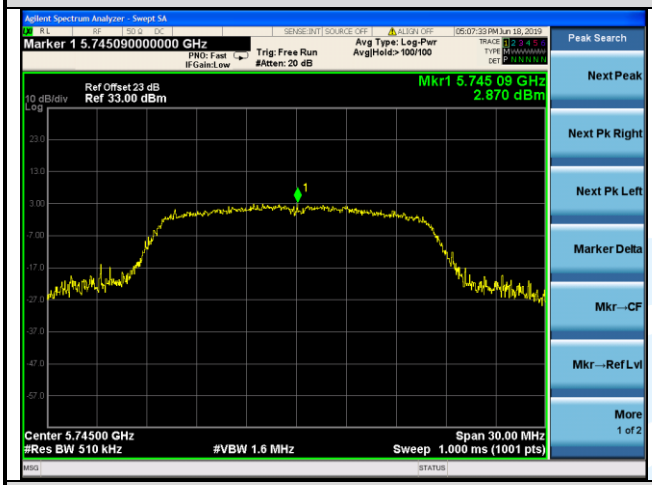
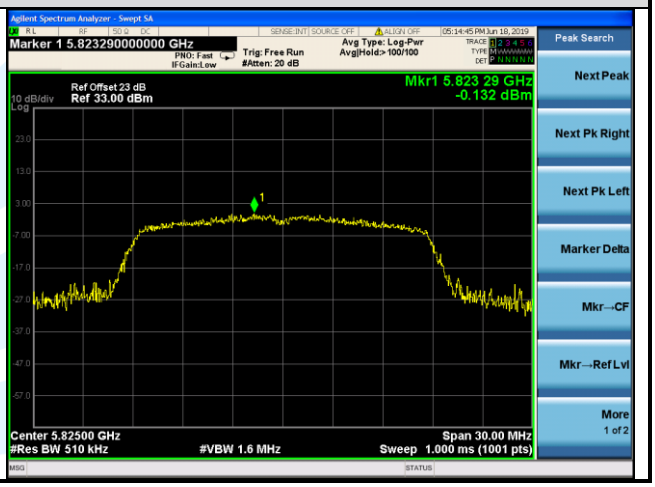
Remark:

1. Corr'd PSD = Meas PSD + Duty Cycle Factor

The test plots as follows:

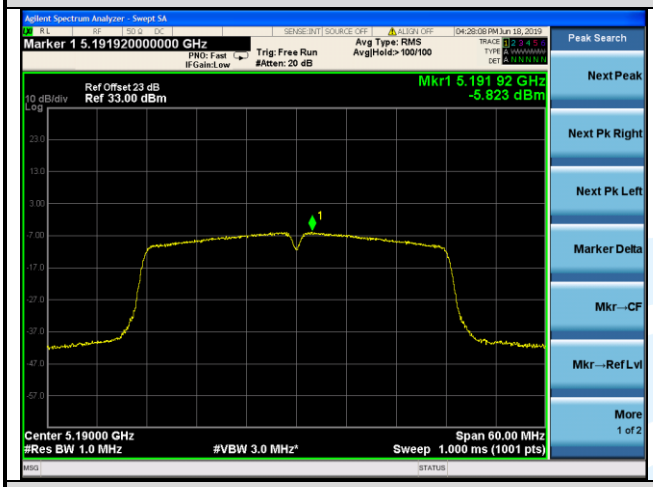
IEEE 802.11a	IEEE 802.11n-HT20
Channel 36	
	
Channel 44	
	
Channel 48	
	

IEEE 802.11a	IEEE 802.11n-HT20
Channel 100	
	
Channel 116	
	
Channel 140	
	

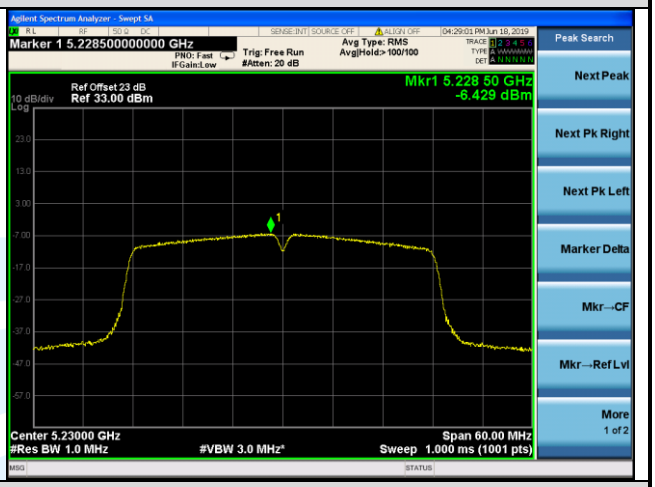
IEEE 802.11a	IEEE 802.11n-HT20
Channel 149	
	
Channel 157	
Channel 165	
	

IEEE 802.11n-HT40

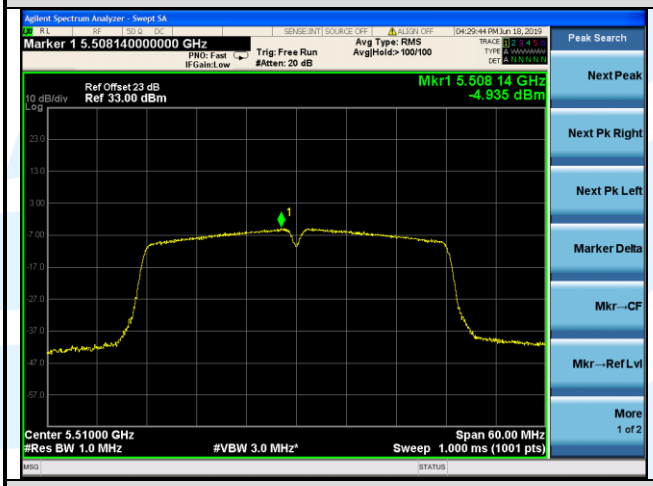
Channel 38



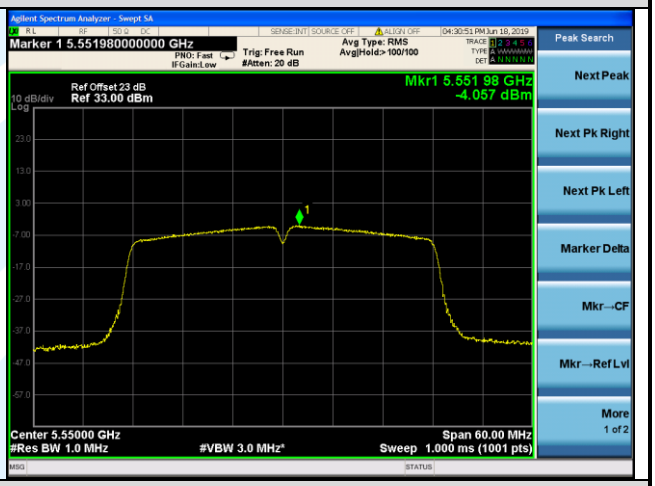
Channel 46



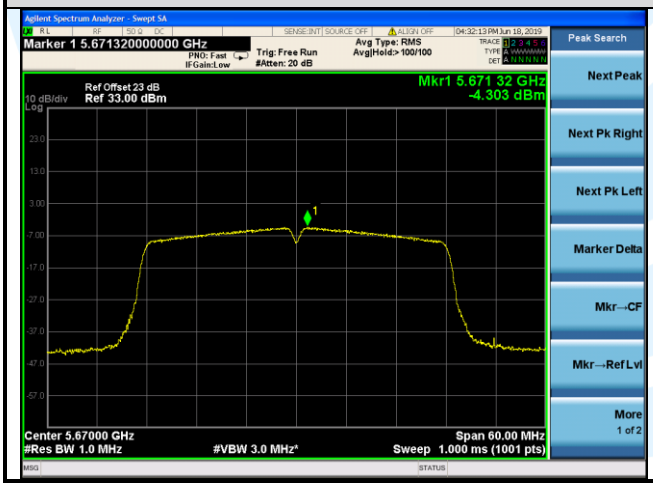
Channel 102



Channel 110

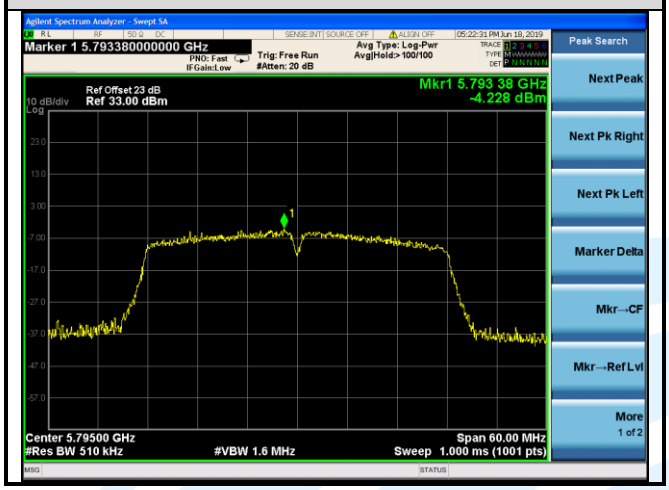


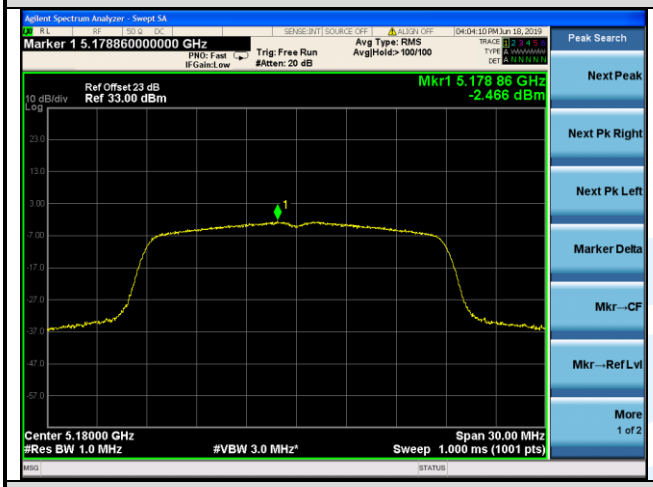
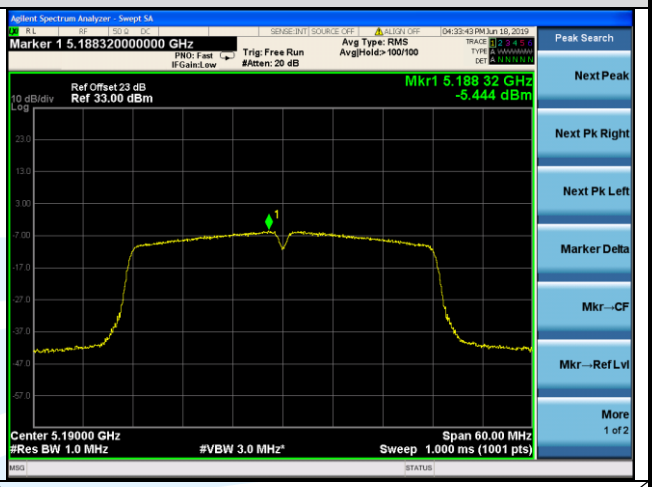
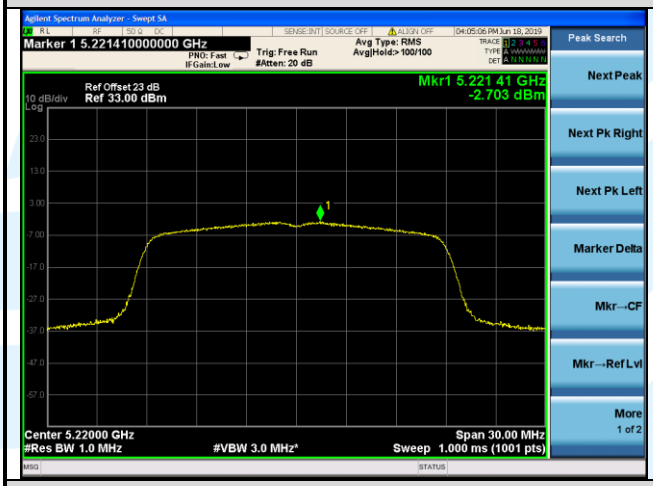
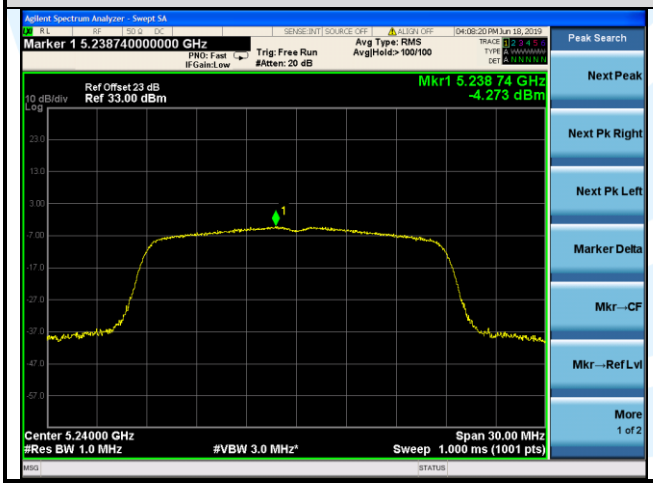
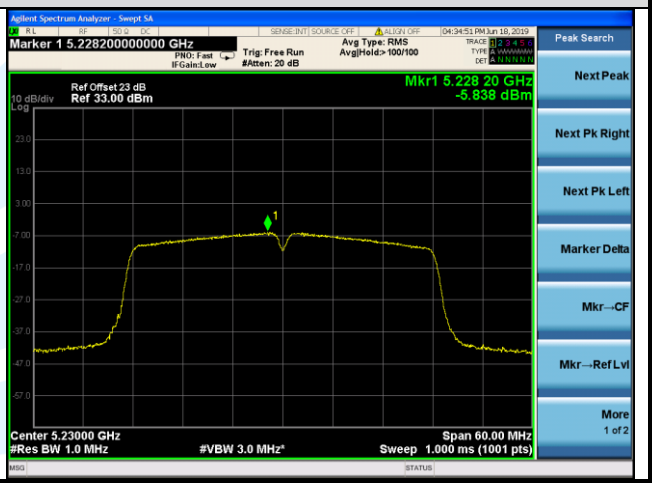
Channel 134

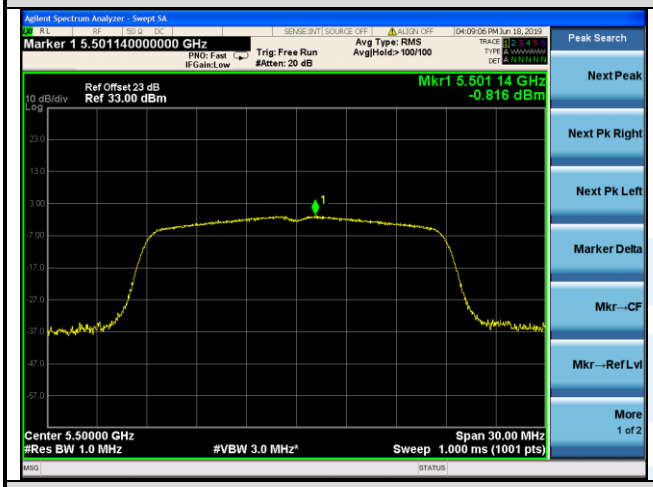
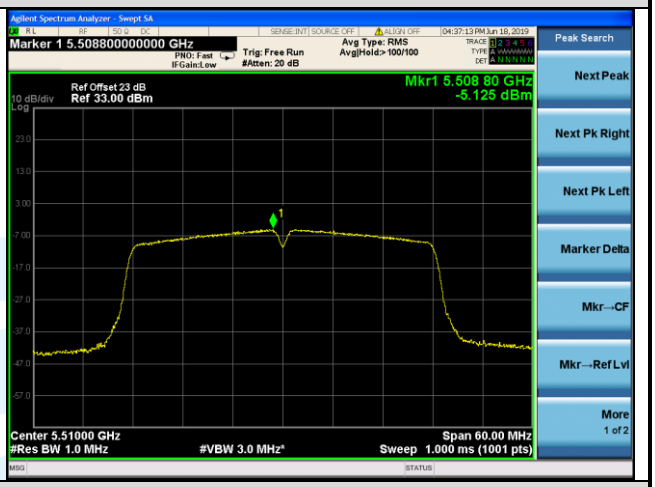
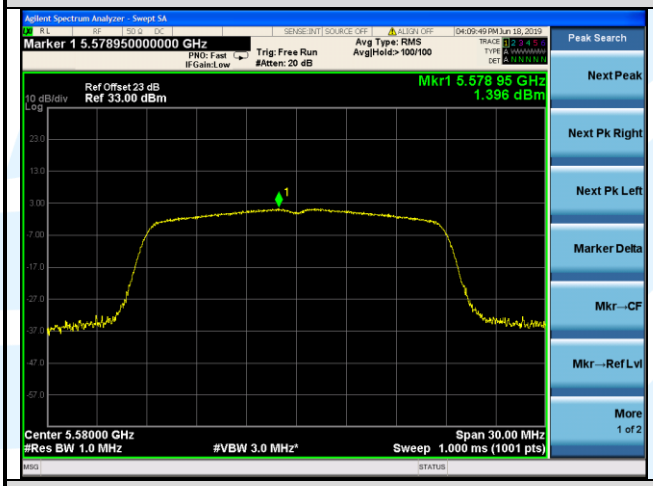
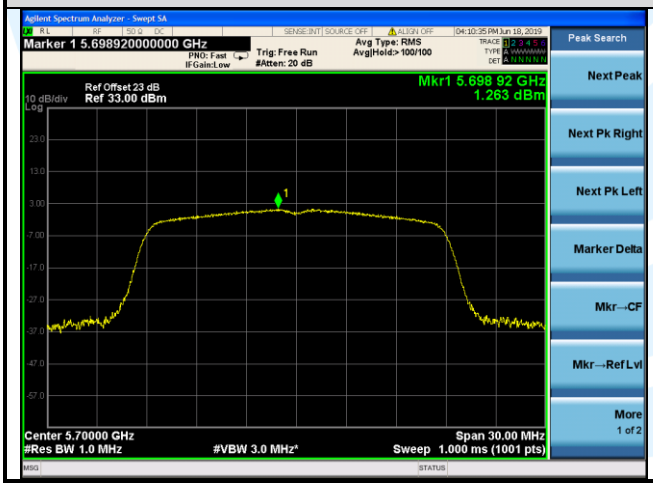
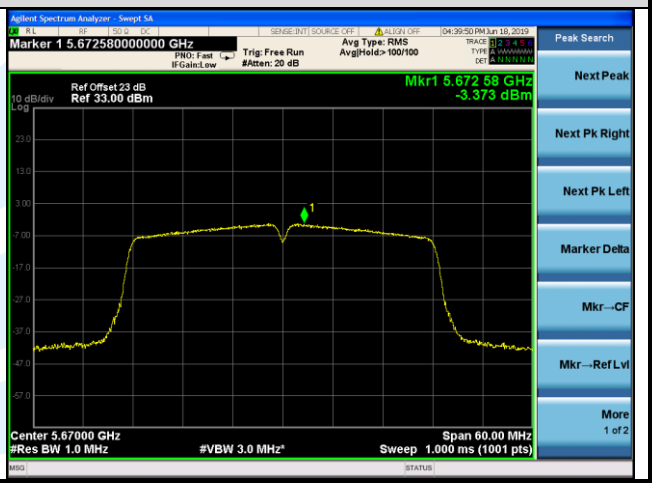


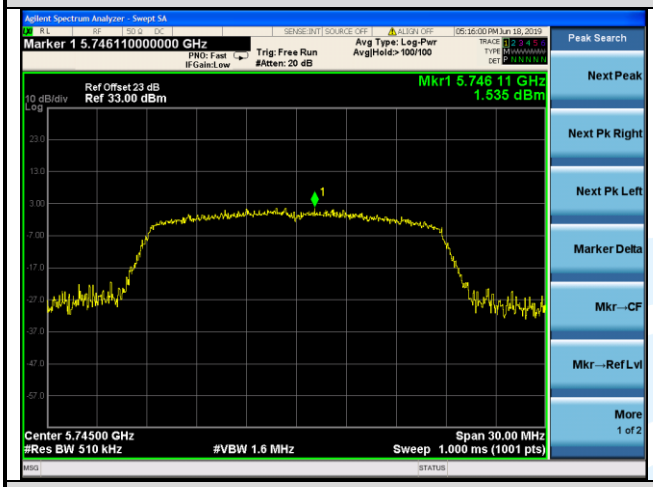
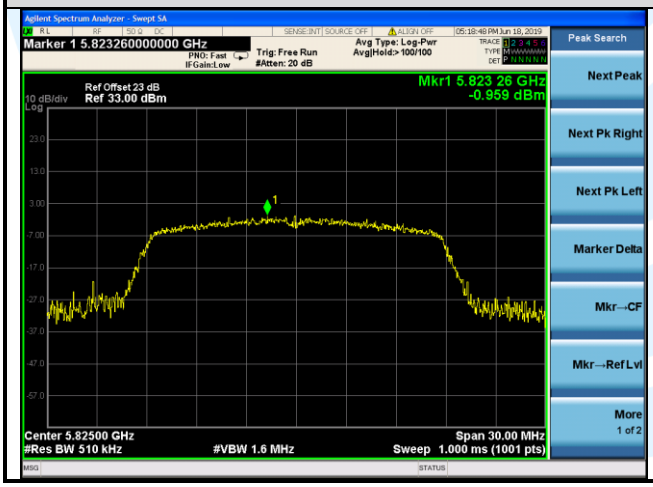
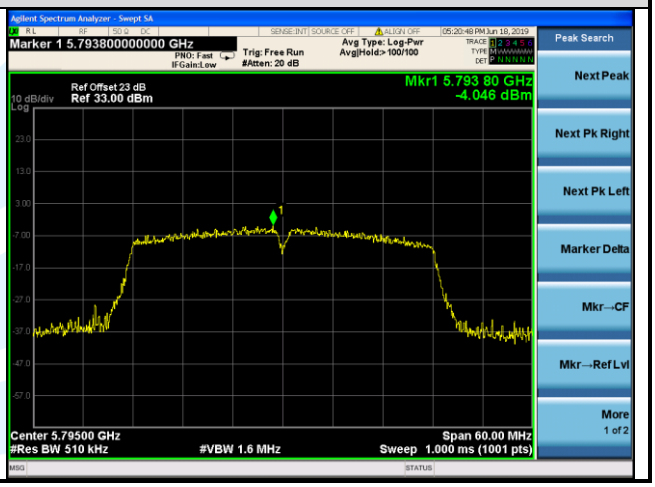
Channel 151

IEEE 802.11n-HT40
Channel 159



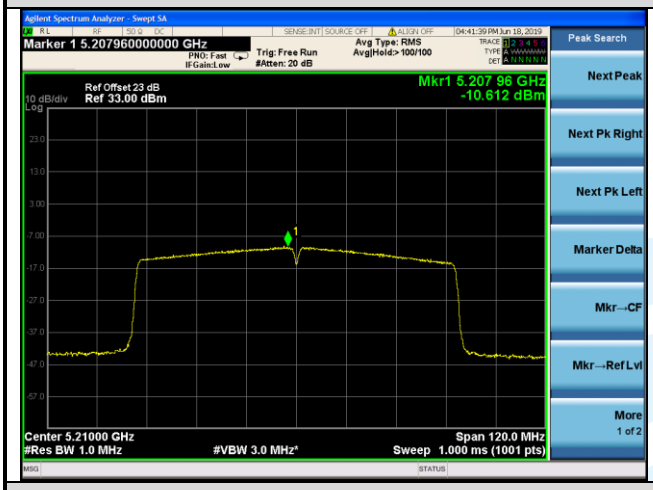
IEEE 802.11ac-VHT20	IEEE 802.11ac-VHT40
Channel 36	**Channel 38**
	
Channel 44	
	
Channel 48	**Channel 46**
	

IEEE 802.11ac-VHT20	IEEE 802.11ac-VHT40
Channel 100	**Channel 102**
	
Channel 116	**Channel 110**
	
Channel 140	**Channel 134**
	

IEEE 802.11ac-VHT20	IEEE 802.11ac-VHT40
Channel 149	**Channel 151**
	
Channel 157	
Channel 165	**Channel 159**
	

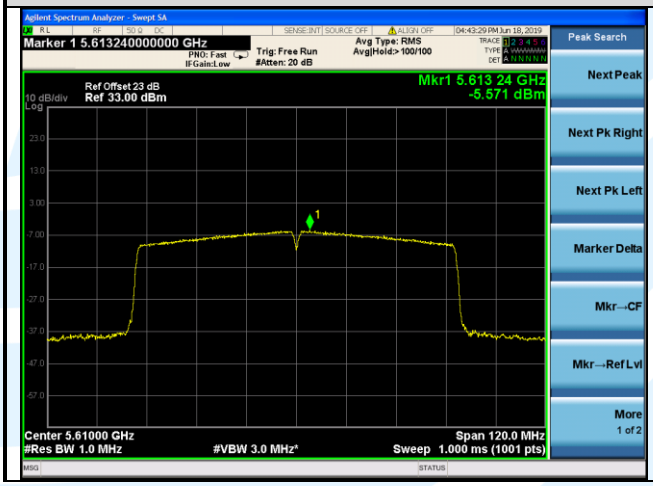
IEEE 802.11ac-VHT80

Channel 42



Channel 106

Channel 122



Channel 155

5.7 RADIATED EMISSIONS AND BAND EDGE MEASUREMENT

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(1)(2)(3)(4)(6)
FCC 47 CFR Part 15 Subpart C Section 15.209/205

Test Method: KDB 789033 D02 v02r01 Section G.3, G.4, G.5, and G.6

Receiver Setup:

Frequency	RBW
0.009 MHz-0.150 MHz	200/300 kHz
0.150 MHz -30 MHz	9/10 kHz
30 MHz-1 GHz	100/120 kHz
Above 1 GHz	1 MHz

Limits:

1. Limits of Radiated Emission and Band edge Measurement

Radiated emissions that fall in the restricted bands must comply with the general emissions limits in 15.209(a) as below table. Other emissions shall be at least 20 dB below the highest level of the desired power.

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009 MHz-0.490 MHz	2400/F(kHz)	--	--	300
0.490 MHz-1.705 MHz	24000/F(kHz)	--	--	30
1.705 MHz-30 MHz	30	--	--	30
30 MHz-88 MHz	100	40.0	Quasi-peak	3
88 MHz-216 MHz	150	43.5	Quasi-peak	3
216 MHz-960 MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1 GHz	500	54.0	Average	3

Remark:

a. The lower limit shall apply at the transition frequencies.
b. Emission level (dBuV/m) = 20 log Emission level (uV/m).
c. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

2. Limits of Unwanted Emission Out of the Restricted Bands

Applicable To	Limit	
789033 D02 General U-NII Test Procedures New Rules v01r04	Field Strength at 3 m	
	PK: 74 (dBμV/m)	AV: 54 (dBμV/m)
Applicable To	EIRP Limit	Equivalent Field Strength at 3 m
FCC Part 15.407 (b)(1)	PK: -27 (dBm/MHz)	PK: 74 (dBμV/m)
FCC Part 15.407 (b)(2)	PK: -27 (dBm/MHz)	PK: 74 (dBμV/m)
FCC Part 15.407 (b)(3)	PK: -27 (dBm/MHz)	PK: 68.2 (dBμV/m)
FCC Part 15.407 (b)(4)	27 dBm/MHz at frequencies from the band edges decreasing linearly to 15.6 dBm/MHz at 5 MHz above or below the band edges;	PK: 68.2 (dBμV/m)
	15.6 dBm/MHz at 5 MHz above or below the band edges decreasing linearly to 10 dBm/MHz at 25 MHz above or below the band edges;	
	10 dBm/MHz at 25 MHz above or below the band edges decreasing linearly to -27 dBm/MHz at 75 MHz above or below the band edges;	
	-27 dBm/MHz at frequencies more than 75 MHz above or below the band edges.	

Test Setup: Refer to section 4.5.1 for details.